

***Foliomolgus cucullus*, a new genus and species of Clausidiidae
(Crustacea: Copepoda: Poecilostomatoida) associated with a
polychaete in Korea**

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Abstract.—*Foliomolgus cucullus*, new genus and species, is described as an associate of the polychaete *Marphysa sanguinea* (Montagu) inhabiting the intertidal sands in Jeju Island in Korea Strait. The new genus possesses primitive features such as the complete segmentation and setation of rami on legs 1–4, 7-segmented antennule, 4-segmented antenna, and 5-segmented female urosome. It possesses also characteristic features such as a spatulate distal segment of the maxilla, foliaceous ventral elements and rudimentary dorsal claw on the mandible, atrophied distal segment of the antenna, and no maxilliped in the female.

The copepods of the family Clausidiidae have been considered to be the most ancestral group of the order Poecilostomatoida. They are found on/in various tubicolous invertebrates, including crustaceans, bivalves, and polychaetes.

The host of the new genus, *Marphysa sanguinea* (Montagu), is a cosmopolitan species of Polychaeta occurring in warm seas (Imajima & Hartman, 1964). Kim (2000) reported *Clausia lobata* as a new species of copepod associated with *M. sanguinea* from the Yellow Sea. During a recent field survey in Jeju Island, the largest island in Korea, a number of the same polychaete species were collected from the intertidal sands, and searched for copepod associates. At this island *C. lobata* was not found on the same polychaete, but, instead, a new species of Copepod belonging to a new genus of the family Clausidiidae was collected. Although only one female and two males were found, they were large enough to facilitate a thorough study, leaving type specimens available for future study.

Before microscopic observation and dissection, copepod specimens were cleared in

lactic acid. Dissections were done using the reversed slide method (Humes & Gooding, 1964). Drawing was done with the aid of a camera lucida. In the description of species, the body lengths were measured from the anterior tip of the cephalothorax to the posterior margin of the caudal rami, excluding the caudal setae. In the formula for the armature of legs 1–4 the Roman numerals indicate spines and the Arabic numerals represent setae.

Family Clausidiidae Embleton, 1901
Foliomolgus, new genus

Diagnosis.—Clausidiidae. Body cyclopiform, relatively large, 9-segmented in female and 10-segmented in male. Prosome composed of cephalothorax and 3 metasomites. Fifth pedigerous somite of female with dorsal hood. Antennule 7-segmented; setation as for the species. Antenna 4-segmented; third segment with 1 claw and 3 setae; terminal segment atrophied, armed with 4 spiniform setae and 3 simple setae. Labrum reduced, incompletely covering oral appendages. Mandible with atrophied terminal process and 3 foliaceous subter-

minal elements. Paragnath encircling mouth, with 2 lobate processes on inner margin. Maxillule distally bilobed, with 3 and 5 setae on respective lobes. Maxilla 2-segmented, simplified, and armed with 1 seta on basal segment and 2 setae on digitiform distal segment. Maxilliped absent in female. Male maxilliped of well-developed and composed of 4 segments, including terminal claw. Legs 1–4 with 3-segmented rami; setation as for the species. Leg 5 with 1 seta on basal segment and 4 setae on distal segment. Basal segment of male leg 5 fused with fifth pedigerous somite. Male leg 6 represented by 1 seta on genital flap.

Etymology.—The generic name *Foliomolgus* is a combination of *folium* (=leaf in Latin) and *molgus* (the ending of many generic names of copepod associates). It alludes to the foliaceous subterminal elements on the mandible in both sexes. The gender is masculine.

Type species.—*Foliomolgus cucullus*, new species

Foliomolgus cucullus, new species

Figs. 1–3

Type specimens.—One female and two males found on the external surface of the polychaete *Marphysa sanguinea* (Montagu) collected from the intertidal coral sands at Sinhung-ri on the northern shore of Jeju Island (approximately 33°33'N, 126°39'E), on 3 Jun 2000. Holotype female (USNM 309082; left antennule, left antenna, and oral appendages dissected out and mounted on a slide) and allotype (USNM 309083; an intact male) have been deposited in the National Museum of Natural History, Smithsonian Institution. Dissected paratype (one male) is retained in the collection of the author.

Female.—Body (Fig. 1A) cycloform, 2.67 mm long. Greatest width 1.02 mm. Prosome composed of cephalothorax and three pedigerous somites. Rostral area of cephalosome produced anteriorly. Prosomal somites with well developed epimera. Epimera of second and third pedigerous so-

mites with pointed posterior corners. Epimeron of fourth pedigerous somite with rounded corners. Urosome (Fig. 1C) slender and five-segmented. Fifth pedigerous somite 405 μm wide, characteristically with dorsal hood (487 μm wide) covering most of dorsal surface of fifth pedigerous somite and anterior part of genital double-somite (Fig. 1B). Genital double-somite 335 \times 295 μm , widest in anterior third, then tapering posteriorly. Genital area located laterally, invisible from dorsal and ventral views. Three abdominal somites 210 \times 165, 162 \times 142, and 115 \times 115 μm , respectively. Anal somite with spinules along posteroventral border. Caudal ramus slender, divergent, 221 \times 40 μm (5.53:1), with parallel lateral margins and 6 setae. Posteroventral border of caudal ramus armed with several denticles (Fig. 1D). All caudal setae naked. One of terminal setae distinctly larger than others, 1.05 mm long.

Egg sac not seen.

Rostrum wider than long, rounded posterior margin (Fig. 1E). Antennule (Fig. 1F) 7-segmented, 731 μm long, with armature formula 5, 15, 6, 3, 4+1 aesthetasc, 2+1 aesthetasc, and 7+1 aesthetasc. Antenna (Fig. 2A) 4-segmented, elongate, with armature formula 1, 1, 3+1 claw, and 7. First and second segments slender, each about 3 times as long as wide. Seta on these segments relatively small and naked. Third segment armed with spinules on inner margin. Claw on this segment prominent, one of three setae very small. Fourth segment originating from proximal part of outer margin of third segment, wider than long, armed terminally with 4 spiniform setae and 3 simple setae, outermost seta plumose.

Labrum (Fig. 2B) reduced, distinctly shorter than wide, covering only part of oral appendages. Mandible (Fig. 2C) armed with 1 terminal fleshy, atrophied element tipped with a small claw-like process, and 3 long, very thin, foliaceous subterminal elements covered with minute spinules on all surfaces. Paragnath (Fig. 2D) with 2 hairy lobes on medial side. Maxillule (Fig. 2E) taper-

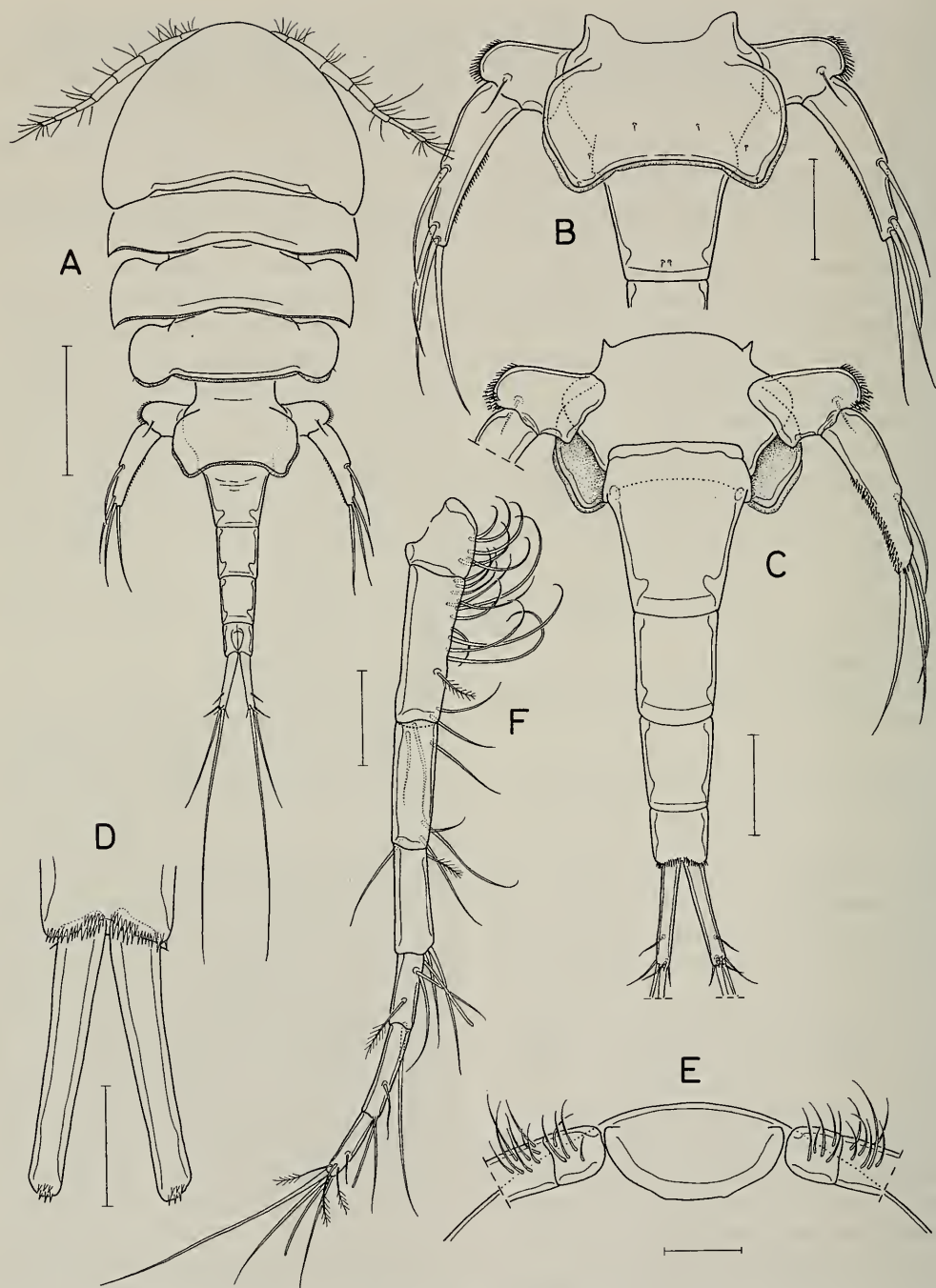


Fig. 1. *Foliomolgus cucullus*, new genus, new species, female. A, habitus, dorsal; B, anterior part of urosome, dorsal; C, urosome, ventral; D, caudal rami, ventral; E, rostral area, ventral; F, antennule. Scale bars: A, 0.5 mm; B, C, 0.2 mm; D-F, 0.1 mm.

ing, proximally with several setules, and terminally bilobed, with 5 setae (3 lateral ones larger) on anterior lobe and 3 setae on posterior lobe. Maxilla (Fig. 2F) 2-segmented. Basal segment greatly expanded proximally, roughly triangular, with 1 terminal seta. Distal segment terminally truncated and sclerotized, and armed with 3 unequal lateral setae; terminal portion of distal segment covered with numerous, minute spinules (Fig. 2G). Maxilliped absent.

Leg 1 (Fig. 2H), leg 2 (Fig. 3A), leg 3, and leg 4 (Fig. 3B) with 3-segmented rami. All these legs spiniferous. All legs with 1 large inner coxal seta; those of legs 1–3 plumose on one side and weakly spinulated on the other side. Inner spine on basis of leg 1 shorter than first endopodal segment of same leg. Posteromedian part of basis of legs 1–4 ornamented with spinules. Each leg with endopod distinctly longer than exopod. Formula of armature of these legs as follows:

- Leg 1: coxa 0–1; basis 1–I;
 exp. I–0; I–1; I, 7
 enp. 0–1; 0–1; I, 5
- Leg 2 & 3: coxa 0–1; basis 1–0;
 exp. I–0; I–1; II, 7
 enp. 0–1; 0–2; III, 3
- Leg 4: coxa 0–1; basis 1–0;
 exp. I–0; I–1; I, 7
 enp. 0–1; 0–2; III, 2

Leg 5 2-segmented (Fig. 1B, C). Basal segment articulating with fifth pedigerous somite, distally armed with 1 small seta and spinules. Distal segment elongate, tapering, armed with 1 outer lateral and 3 terminal setae; all setae naked, and as long as or shorter than distal segment. Leg 6 not seen.

Male.—Body (Fig. 3C) similar to that of female. Length 2.20 mm. Urosome (Figure 3D) 6-segmented. Genital somite $175 \times 317 \mu\text{m}$, distinctly narrower than fifth pedigerous somite, without dorsal hood. Genital flap with numerous spinules near inner margin. Four

abdominal somites 154×187 , 175×155 , 150×135 , and $104 \times 113 \mu\text{m}$, respectively. Caudal ramus $198 \times 33 \mu\text{m}$ (6.0:1), more slender than that of female.

Antennule with 1 additional seta on distal portion of third segment. Antenna, labrum, paragnath, and maxillule similar to those of female. Mandible (Fig. 3E) with more prominent claw on tip of terminal element. Maxilla (Fig. 3F) with first segment not expanded, but distal segment as in female. Maxilliped (Fig. 3G) 4-segmented. First segment with 1 long distal seta. Second segment triangular, greatly expanded proximally, strongly tapering, with a flat, thin protrusion at inner proximal corner, and armed with 2 rows of thin, truncate spinules (one row shorter), 2 rows of epicuticular extensions and 2 small setae (one in the middle, the other smaller one in distal part) on inner margin. Third segment short and unarmed. Terminal segment forming a claw bearing proximally 2 setae and 1 distal membranous process.

Legs 1–4 as in female. Basal segment of leg 5 completely fused with fifth pedigerous somite, leaving only 1 distal seta. Free distal segment broader and shorter than that of female (Fig. 3D). Leg 6 represented by 1 stiff seta on terminal corner of genital flap.

Etymology.—The specific name *cucullus* (=hood in Latin) alludes to the hood-like dorsal coverture on the fifth pedigerous somite of the female.

Discussion

The genus *Hemicyclops* best illustrates general features of the family Clausidiidae (Humes, 1987). The new genus *Foliomolgus* belongs to the Clausidiidae, because it shares with *Hemicyclops* the important characters such as the 7-segmented antennule, 3-segmented rami on legs 1–4, inner spine on the basis of leg 1, 4-segmented antenna armed with four and seven elements respectively on the third and terminal segments, and 5+3 setae on the maxillule.

Humes & Huys (1992) recognized seven

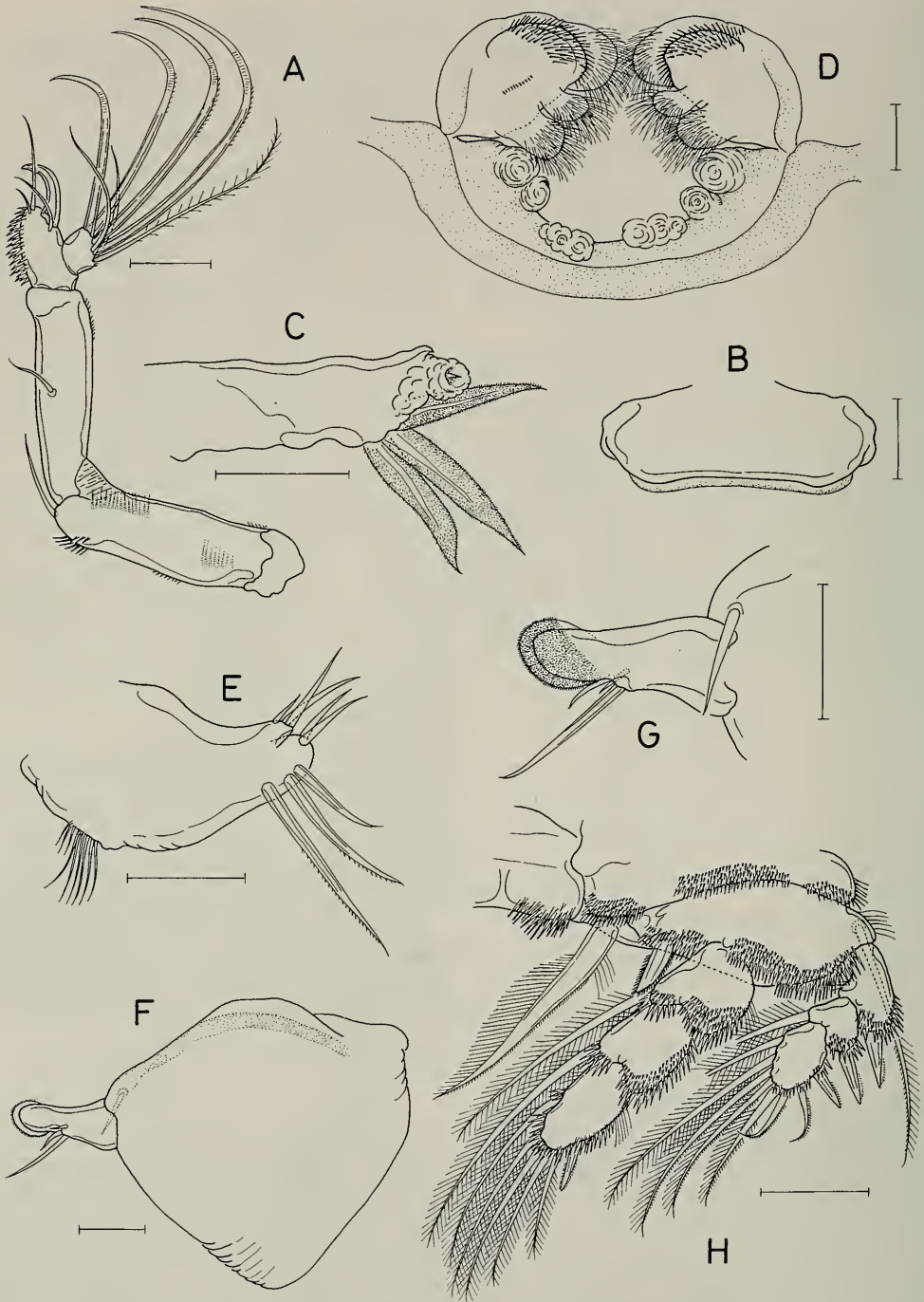


Fig. 2. *Foliomolgus cucullus*, new genus, new species, female. A, antenna; B, labrum; C, mandible; D, mouth area, including paragnaths; E, maxillule; F, maxilla; G, distal part of maxilla; H, leg I. Scale bars: A-C, E-F, 0.05 mm; D, 0.02 mm; H, 0.1 mm.

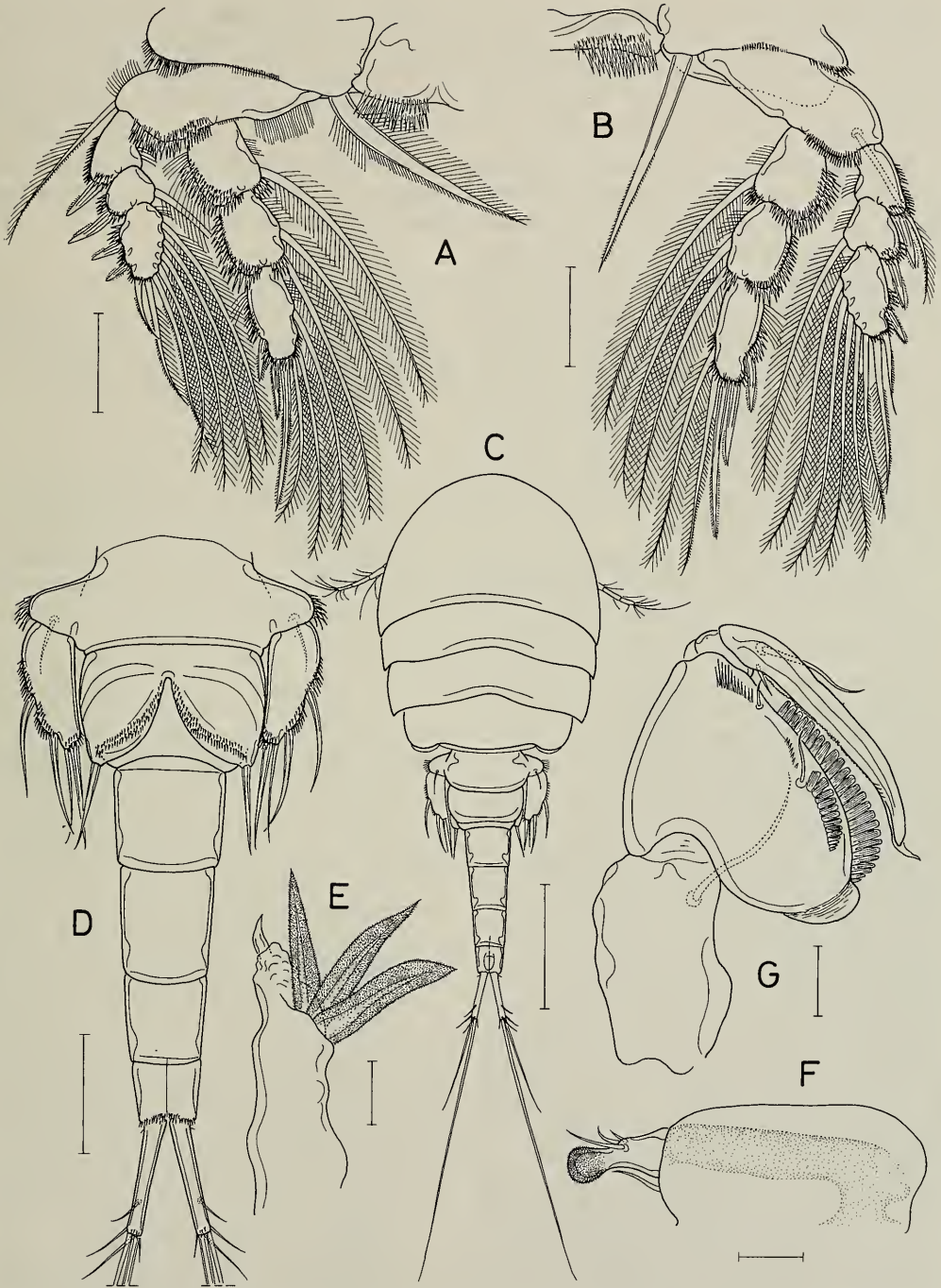


Fig. 3. *Foliomolgus cucullus*, new genus, new species. Female: A, leg 2; B, leg 4. Male: C, habitus, dorsal; D, urosome, ventral; E, mandible; F, maxilla; G, maxilliped. Scale bars: A, B, 0.1 mm; C, 0.5 mm; D, 0.2 mm; E, 0.02 mm; F, G, 0.05 mm.

genera as valid in the Clausidiidae: *Clausidium* Embleton, *Conchylurus* Bocquet & Stock, *Doviella* Rocha, *Hemicyclops* Boeck, *Hippomolgus* Sars, *Hyphalion* Humes, and *Leptinogaster* Pelseneer. In the same year, Ho & Wardle (1992) added a new genus *Pholadicola* to this family. Because one of these genera, *Doviella*, is a junior synonym of *Clausia* of the Clausiidae (Kim, 2001), the Clausidiidae currently consists of seven genera. In the absence of a maxilliped in the female and having a claw on the third segment of the antenna, *Foliomolgus* is comparable to the genera *Leptinogaster* and *Pholadicola*. However the latter two genera, both associates of bivalves, carry a 6-segmented antennule, and fewer setae on the antenna, maxillule and legs.

The morphology of the mandible, bearing the rudimentary dorsal (posterior) element (claw) and three well-developed foliaceous ventral (anterior) elements, is a unique feature of the new genus *Foliomolgus*. As far as the Clausidiidae and related families, the nereicoliform copepods of Gooding (1963), are concerned, the size reduction of mandibular elements usually involves the ventral ones. The extreme case of this armature reduction, where only the dorsal claw-like element is retained, is exhibited by some genera of Catiniidae, Clausiidae, and Synaptiphilidae. In contrast to this general trend of armature reduction, a mandible similar to that of the new genus may be seen in copepodid I of *Conchylurus* (see Kim, 1994; only three ventral elements are retained in the adult) and the adult of *Myzomolgus* where the dorsal claw is reduced and the ventral elements are developed.

In addition to the mandible, the antenna also is characteristic within the Clausidiidae and related families. In this appendage the third segment is produced distally along the main axis of the appendage; the fourth segment is displaced laterally.

The transformation of the maxilla in which the distal segment is a spatulate lobe,

one of the diagnostic features of the new genus, is a general feature observed in the Clausiidae, Nereicolidae and Serpulidicolidae, the copepods generally associated with the polychaetes. Therefore the similarity of the maxilla in these copepods may be a convergence resulting from the association with similar hosts.

Acknowledgement

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Literature Cited

- Gooding, R. U. 1963. External morphology and classification of marine poecilostome copepods belonging to the families Clausidiidae, Clausiidae, Nereicolidae, Eunicicolidae, Synaptiphilidae, Catiniidae, Anomopsyllidae, and Echiurophilidae. Unpublished Ph.D. thesis, University of Washington, Seattle, 276 pp.
- Ho, J.-S. & W. J. Wardle. 1992. *Pholadicola intestinalis*, new genus and species, a clausidiid copepod parasitic in a deep-burrowing clam from Texas.—*Bulletin of Marine Science* 51:37–44.
- Humes, A. G. 1987. Copepoda from deep-sea hydrothermal vents.—*Bulletin of Marine Science* 41: 645–788.
- , & R. U. Gooding. 1964. A method for studying the external anatomy of copepods.—*Crustaceana* 6:238–240.
- , & R. Huys. 1992. Copepoda (Poecilostomatoida and Siphonostomatoida) from deep-sea hydrothermal vent areas off British Columbia, including *Amphicrossus altalis*, a new species of Erebonasteridae, with note on the taxonomic position of the genus *Tychidion* Humes.—*Canadian Journal of Zoology* 70:1369–1380.
- Imajima, M., & O. Hartman. 1964. The polychaetous annelids of Japan, Part II. Allan Hancock Foundation Publications, Occasional Paper 26, 452 pp.
- Kim, I.-H. 1994. Copepodid stages of *Conchylurus quintus* Tanaka, 1961 (Poecilostomatoida, Clausidiidae) associated with bivalve mollusks.—*Hydrobiologia* 292/293:161–169.
- . 2000. Poecilostomatoid copepods from an intertidal mud flat in the Yellow Sea.—*Journal of Natural History* 34:367–432.
- . 2001. A new species of *Clausia* (Copepoda, Poecilostomatoida, Clausiidae) associated with the polychaete *Arenicola brasiliensis* Nonata in Korea.—*Hydrobiologia* (in press).